

Overview of System Operations for Fog Detection & Sign Warning Systems

Locations: I-68 at Big Savage Mountain and Keyzers Ridge Areas

The recommended system makes maximum use of the existing infrastructure using the existing RWIS at Big Savage and Keyzers Ridge. Each RWIS site communicates to the SHA District 6 Server via dial-up telephone and controls two or more warning signs via encrypted spread spectrum radio. The warning signs will be powered by solar panels and batteries. When a low visibility situation is detected, the system causes 12" amber LED's to flash on/off at strategically placed warning signs. The system includes a positive confirmation of the operation of the flashing LED's.

Each system event is logged on the System Server located in District 6. If a command is issued and the system does not respond as intended, an error condition is identified and the system responds as programmed. Depending on the type of error, the system may issue a page and/or display an error message on the screen. The system always logs the event.

Equipment Description

There are four significant subsystems that are employed on this project: the RWIS equipment, the solar power system, the warning sign system, and the encrypted spread spectrum radio communications system.

RWIS

The RWIS station is a standard station as installed at Big Savage and Keyzers Ridge. Minor equipment modifications and upgrades were made as necessary to detect the low visibility situation with interfaces to the radio and dial-up communications systems, issue commands to the LED flashers, monitor the LED status, and interface with the Server.

Solar Power System

Because the warning signs and radios must be located in areas where AC power is difficult and expensive to provide, the system is designed to use solar power. At each warning sign, the solar power system will provide power for:

- Alternating flashing beacons;
- Encrypted spread spectrum radio,
- Solar panel controller.

The key elements in the design of the solar power system are the size of the batteries and the size of the solar panels that are used to recharge the batteries. The system is required to operate the flashers for 72 hours with no significant sun light. The solar panels are

connected to the batteries through a controller which regulates the charging and discharging rate of the batteries. Each of the parts of the solar power system is described below:

Solar Panels: Each assembly shall use two solar panels. The panels shall be Siemens SM55 or equivalent. The solar panels are off the shelf items and warranted for 20 years. They are mounted at the top of a wood pole (40ft. pole height) which uses a bracket to tilt the panels to the south at the optimum angle. The battery and electronics enclosure is also mounted on this pole. The solar panels use 36 solar cells. These cells make optimum use of the module surface area because of their square shape. They are highly efficient and provide the maximum power possible under low light level conditions. The hardened front glass has excellent light transmitting properties and protects the module against most adverse environmental conditions such as hail or ice. The solar cells are laminated in EVA (ethylene-vinyl acetate) between a multilayer rear film and the front glass. This permanently laminated assembly protects the cells against moisture and ensures electrical insulation. The panel is supported by a torsion-resistant module frame made of anodized aluminum.

Controller: The controller manages the charge of the batteries. The controller is a solid state device and provides temperature compensated charging so that the rate of charge is controlled for both temperature and state of charge variations. The controller will shut off charging when the battery reaches a charge of 15.2 VDC. The controller will disconnect the load when the battery voltage reaches 11.4VDC. These set points have been established to prevent damage to the battery from an overcharge condition or a low voltage condition. The controller shall have a manual disconnect switch that allows one to electrically disconnect the batteries from the system. The controller uses an LCD display to show the battery voltage, array current, and load current.

Battery: The battery stores the electrical energy which powers the load. Batteries shall be maintenance free sealed gel, absorbed mat technology. The battery type shall be a sealed, maintenance-free, valve-regulated design. The battery shall use an Absorbed Glass Mat (AGM) to suspend the electrolyte. The capacity of each battery shall be 115Ah at 25°. Each battery shall have a copolymer polypropylene case and cover and have non-removable, pressure-regulated, flame arresting safety valves. The rated operating temperature shall be from -40°C to +72°C. The battery shall have a self-discharge rate better than 1% per month at 25°C. The supplier shall determine the number of batteries to be supplied to meet the 72-hour operation requirement.

Battery and Electronics Enclosure: The enclosure shall house the 115 Ah batteries (Group 27) and the electronics in two separate compartments. The enclosure shall be fabricated from aluminum with a minimum wall thickness of 0.125 inches. The battery compartment shall have a minimum of 1/2" Styrofoam sheeting to minimize heat transfer between the batteries and the enclosure wall. The enclosure shall be sized to hold the required number of batteries.

Warning Sign

The purpose of the warning signs is to inform the motorist that there is a reduced visibility situation ahead of them. This is a task similar to the "Shazam" signs used by the SHA to inform motorists of a Highway Advisory Radio (HAR) broadcast. The "Reduced Visibility"

sign itself will be provided by SHA. The Contractor shall supply the support structure, the foundation and anchor bolts, the LED displays, and shall install the sign and LED's.

The sign assembly shall have a sensor that provides a continuous output when power is applied to the LED's. This output is provided to the radio as a positive indication when the LED's are operational.

LED Displays: The LED beacons shall be nominal 12" and shall meet the current SHA standards. The LED elements shall be optimally matched and provide a uniform Yellow color output. The lamps incorporate multiple main circuits. All lamps use a self-regulating circuit to accommodate input voltages from 10.5 VDC to 18.0 VDC.

Flasher: The flasher shall be a 12VDC, solid state flasher that consumes negligible power during operation. The unit supports two flasher outputs with an alternating flash operation. When flashing, the unit will have an output duty cycle of 50% per lamp and be capable of 50 to 60 flashes per minute for each lamp. The flasher is housed in the Battery and Electronics Enclosure.

Spread-spectrum Radio

The radio shall be a standard, off-the-shelf unit designed for the traffic control and SCADA industries. The radio system shall be one designed for remote data collection applications or any applications that require the transfer of contact closures.

The basic design calls for a Point to Multi-point configuration where contact closures are transmitted from a central location to multiple receivers (warning signs), and supports a status contact closure return. The radio system uses license-free spread spectrum technology.

The system will employ a radio transmitter at each of the RWIS sites. When the RWIS equipment detects a low visibility situation, it provides a contact closure. The contact closure is fed to the radio system and then transmitted to the warning signs. The radio is housed separately from other equipment at both the RWIS transmitter sites and the warning sign receiver sites. The radio system monitors the operation of the LED's and provides a positive feedback when the LED system is operational.

Each transmitter site uses a gain, vertical, omni-directional antenna. Each receive site uses a Yagi directional antenna.

At each warning sign site, the radio equipment cabinet is mounted on the solar panel pole. The Yagi antenna is mounted on the same pole. At the RWIS sites, the vertical antenna is mounted on the site tower and the radio transmitter cabinet is also mounted on the tower.

At one location, Big Savage, it is not possible to have line of sight communications between the RWIS site and the warning sign located to the west of this location. A radio repeater shall be used at this location. The repeater will use an omni antenna. The antennas and the repeater radio equipment shall be mounted on an existing SHA Communications Tower.

Operation Description

The basic plan is to use the two (2) existing RWIS equipment to identify low visibility situations. When this condition exists, the system will turn on warning signs to alert drivers approaching the

low visibility condition. Each site and corresponding signs will operate independently. When the RWIS sensor detects a low visibility situation, the system will initiate flashing operation at each sign via radio.

Each site can be overridden by a direct command from the District 6 Server. The Server shall support three commands: Lock-in Flashing, Lock-out flashing, and Local Control.

- The Lock-in Flashing command shall lock the LED's in flashing mode regardless of the RWIS Visibility Sensor status.
- The Lock-out Flashing command shall lock the LED's off regardless of the RWIS Visibility Sensor status.
- The Local Control command shall cause the system to respond to the RWIS Visibility Sensor status.

An error situation that may occur happens when the low visibility sensor detects a low visibility situation and issues a FLASH command but for some reason (low battery charge for example) there is either no response from the field or a negative response from the field. In this situation, the system must issue an error message, it must have the capability of issuing a telephone page, and the event must be logged.

Commands and Responses

The Server commands the RWIS to Local Control.

1. The RWIS detects a low visibility situation and the LED status is OFF.
 - a) The RWIS commands the LED's to FLASH via radio. The LED status monitor senses that the power is ON and provides an output to respond to the RWIS that the LED's are energized. The event is logged to the Server via dial-up telephone.
 - b) The RWIS commands the LED's to FLASH via radio. The LED status monitor senses that the power is OFF and provides an output to respond to the RWIS that the LED's are NOT energized. This is an error condition. The event is logged to the Server via dial-up telephone. The Server displays an error message on the screen that remains until acknowledged by the operator and (if enabled) the Server dials a pager and transmits the error code.
2. The RWIS detects a low visibility situation and the LED status is ON.

This is a normal condition, no action required.
3. The RWIS detects a normal visibility situation and the LED status is ON.
 - a) The RWIS commands the LED's to OFF via radio. The LED status monitor senses that the power is OFF and provides an output to respond to the RWIS that the LED's are NOT energized. The event is logged to the Server via dial-up telephone.
 - b) The RWIS commands the LED's to OFF via radio. The LED status monitor senses that the power is ON and provides an output to respond to the RWIS that the LED's are energized. This is an error condition. The event is logged to the Server via dial-up telephone. The Server displays an error message on the screen that remains until

acknowledged by the operator and (if enabled) the Server dials a pager and transmits the error code.

4. The RWIS detects a normal visibility situation and the LED status is OFF.

This is a normal condition, no action required.

The Server commands the RWIS to Flash Mode.

The output from the RWIS Visibility sensor is ignored.

- a) The RWIS commands the LED's to FLASH via radio. The LED status monitor senses that the power is ON and provides an output to respond to the RWIS that the LED's are energized. The event is logged to the Server via dial-up telephone.
- b) The RWIS commands the LED's to FLASH via radio. The LED status monitor senses that the power is OFF and provides an output to respond to the RWIS that the LED's are NOT energized. This is an error condition. The event is logged to the Server via dial-up telephone. The Server displays an error message on the screen that remains until acknowledged by the operator and (if enabled) the Server dials a pager and transmits the error code.

The Server commands the RWIS to OFF Mode.

The output from the RWIS Visibility sensor is ignored.

- a) The RWIS commands the LED's to OFF via radio. The LED status monitor senses that the power is OFF and provides an output to respond to the RWIS that the LED's are not energized. The event is logged to the Server via dial-up telephone.
- b) The RWIS commands the LED's to OFF via radio. The LED status monitor senses that the power is ON and provides an output to respond to the RWIS that the LED's are energized. This is an error condition. The event is logged to the Server via dial-up telephone. The Server displays an error message on the screen that remains until acknowledged by the operator and (if enabled) the Server dials a pager and transmits the error code.